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ED&T REPORT NO. 5700-5

OCTOBER, 1963

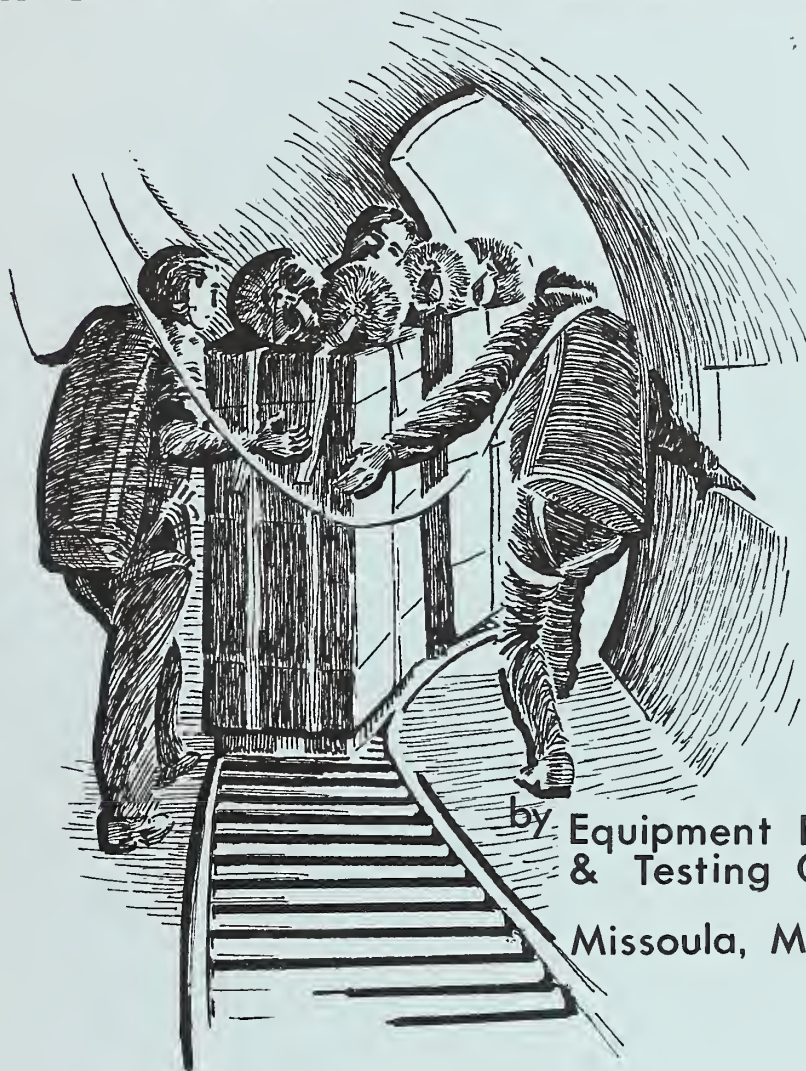
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CARGO CONVEYORS

FOR DC-3 AND C-46 AIRCRAFT

CURRENT SERIAL RECORDS



by Equipment Development
& Testing Center

Missoula, Montana



U. S. DEPARTMENT OF AGRICULTURE

FOREST SERVICE

WASHINGTON D. C.

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
WASHINGTON D.C. 20250

IN REPLY REFER TO

5700

January 15, 1964

The paracargo conveyor system and discharge procedures for DC-3 and C-46 aircraft described in Technical Equipment Report No. 5700-5 are approved for optional U.S. Forest Service use. Specifications, including reduced drawings, are in the report. Full-size drawings may be obtained from the Director, Missoula Equipment Development and Testing Center, Missoula, Montana.

All personnel shall be thoroughly trained in the safe use of this equipment prior to operational service.



MERLE S. LOWDEN, Director
Division of Fire Control



TABLE OF CONTENTS

	<u>PAGE</u>
Abstract	1
Introduction	2
Summary and Conclusions	3
Instructions for Installation and Use of Cargo Roller Conveyors in C-46 and DC-3 Aircraft	4 - 12
Conveyor Components and Accessories	4 - 7
Aircraft Modifications and Accessories	7 - 8
Procedure	8 - 12
Appendix	13

ABSTRACT

This report is the culmination of ED&T No. 1113. The purpose of the project was to develop safer and more economical cargo dropping methods.

Details covering installation and use of cargo rollers for DC-3 and C-46 aircraft are contained in this report.

The project was coordinated with ED&T No. 718, Protective Packaging for Firefighting Tools and Equipment.

INTRODUCTION

With the increasing use of cargo aircraft for supplying firefighters with tools and supplies, and the adoption of larger aircraft for this purpose, the need for revising methods of loading and ejecting paracargo became apparent.

Procedures which suffice for small aircraft and payloads proved inadequate when used with large, multiengined planes. On major fires, the DC-3 and C-46 are now chiefly used for cargo dropping.

The typical load of a C-46 is 8,000 pounds, consisting of packages of about 100 pounds each. With the usual system of manhandling each package to the forward end of the plane, four or five men and considerable time are required for loading.

Upon reaching the drop zone, the situation is repeated. The cargo droppers drag each bundle to the rear door. Usually, only two or three bundles, totaling 200 to 300 pounds, can be ejected at a single pass. Therefore, to empty the C-46 as many as 30 to 40 separate passes over the drop zone are required.

To improve the overall efficiency of paracargo operations a roller conveyor system for large aircraft was needed. Preliminary appraisal indicated that to serve fire control needs the conveyor system must:

1. Handle large, hard and uneven objects.
2. Permit quick installation and removal.
3. Be usable in contract or Forest Service DC-3 and C-46 aircraft.

After investigation and testing, a conveyor system meeting the foregoing requirements was developed. The system incorporates many innovations found useful by military paracargo experts.

During the test phase, the increased efficiency and safety of paracargo operations brought about by using the roller conveyor was demonstrated.

Using roller conveyors, three or four men easily loaded the 8,000-pound payload of the C-46. Without the conveyor four or five men worked hard to do the same job. Over the drop zone three or four bundles were ejected at one pass, reducing flying time by approximately one-third. Cargo searching and retrieving time on the ground was appreciably reduced because packages from each pass land close to each other.

When cargo is consolidated onto large pallets on the conveyor, 600 to 900 pounds can be ejected on a pass. Thus flying time over the drop zone can be reduced 50 percent or more. Considering the costs (\$4 to \$6 per minute) of large aircraft the use of roller conveyors can effect appreciable savings on every mission.

Roller conveyors are safer. Reducing the number of low level runs over the drop zone decreases the danger to the aircraft and crew.

Faster discharge of paracargo alleviates aircraft congestion in the vicinity of large fires. In the event of an aircraft mechanical failure, the roller conveyor will permit rapid jettisoning of the cargo.

This report covers the design, construction and installation of a roller conveyor system for large aircraft. Properly installed and correctly used, the roller system will pay for itself in one or two missions.

SUMMARY AND CONCLUSIONS

Adoption of roller conveyors for large aircraft can save flying time and manpower. Flying time over the drop zone can be reduced by approximately one-third, with commensurate savings in aircraft costs. The safety of the cargo dropping mission is increased.

The use of roller conveyors makes possible consolidation of small packages onto pallets, thus reducing the number of workers required to load and drop paracargo. Reducing the number of individual packages scattered over the drop site will reduce search and retrieving time.

Decreasing the time required to empty the aircraft will help alleviate the congestion of aircraft which tends to occur over large fires.

INSTRUCTIONS FOR INSTALLATION AND USE OF CARGO ROLLER CONVEYORS
IN C-46 and DC-3 AIRCRAFT

CONVEYOR COMPONENTS AND ACCESSORIES

Conveyor system components should be purchased according to the specifications and description given in materials lists.

- I. Conveyor Components -- Beginning at the cargo door and proceeding toward the pilot compartment, the conveyor system consists of these items:
 - A. Curved Section -- A short length of conveyor making a 90-degree arc, from door threshold toward fuselage center line. Accessories include door cargo stop and release (Figure 1), modified coupling hooks, shims and legs to adjust conveyor to aircraft floor profile (Figure 2). See drawing ED-235-R1 for construction details.

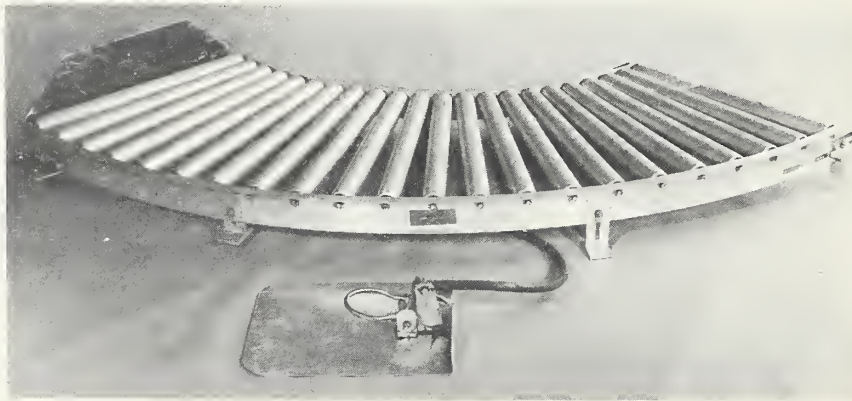


Figure 1

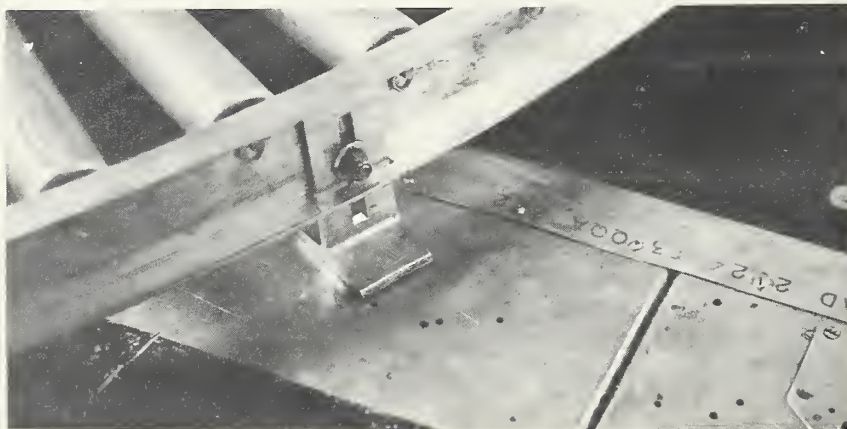


Figure 2

- B. One 8-foot Straight Section -- Fitted with four adjustable legs (Drawing ED-240-R1) and one conveyor clamp (Drawing ED-236-R1). This section is not used in DC-3. (Figure 3)

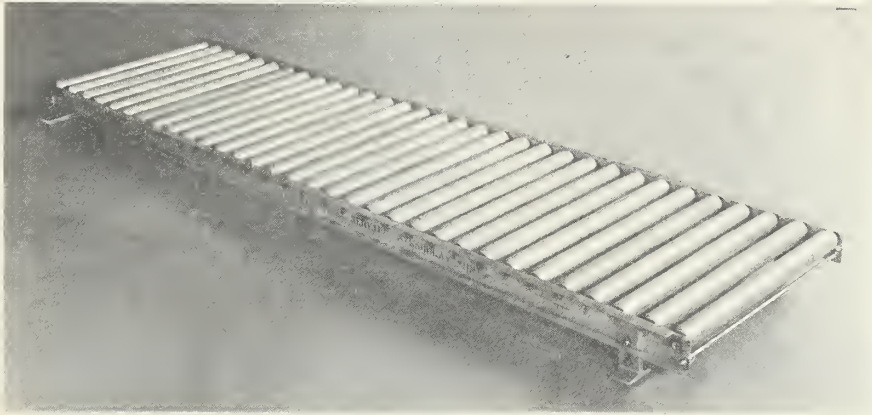


Figure 3

- C. Two 8-foot Straight Sections -- Each section is fitted with two conveyor clamps.
- D. One 5-foot Straight Section -- Fitted with two conveyor clamps. This section is shortened if entire system is too long for aircraft.
- II. Conveyor System Accessories -- Devices which add ease and safety to cargo dropping operations.
- A. Forward Cargo Stop -- Removable metal stop attached to forward end of conveyor (Figure 4) to prevent loads from shifting forward (Drawing ED-235-R1).

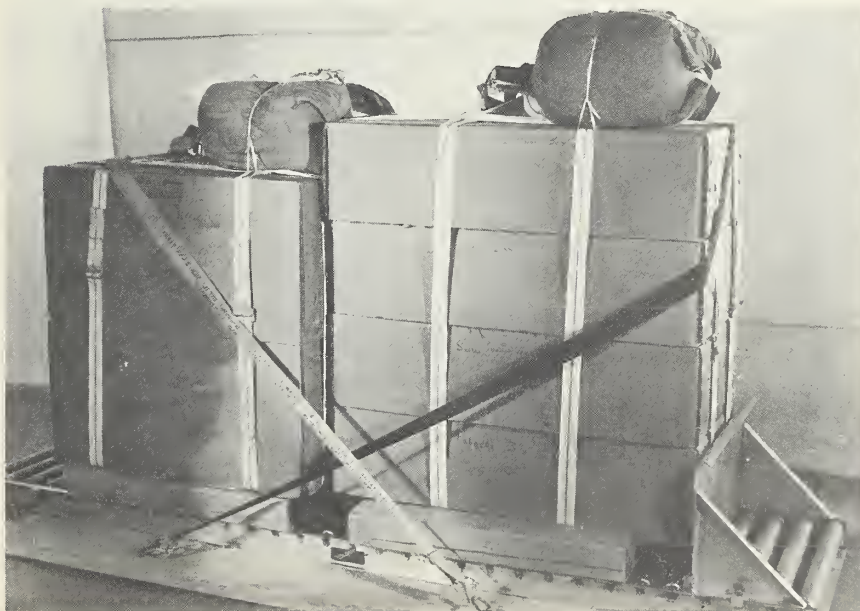


Figure 4

B. Cargo Tiedown Straps -- Ten straps approximately 15 feet in length, breaking strength exceeding 1,500 pounds, are usually sufficient to secure the payload of a C-46. Aeroquip Corporation, General Logistics Division, Burbank, California, manufactures a Model RB 180 AD⁴WB which was used in development tests. (Figure 5).

C. Cargo Tiedown Ropes -- Half-inch manila ropes, 15 to 20 feet long, can be used for aft cargo ties instead of straps. Ropes are easier to untie, can be used to brake bundles being moved toward the door. However, when rope is used, several cargo straps should secure the rear of the load on takeoff. Cargo straps are usually stronger than rope, therefore they are more desirable for securing the entire load from shifting.

D. Cargo Stops (Loading) -- Removable wooden stops placed between rollers to hold packages temporarily. About six will suffice for each conveyor system (Figure 6). (Drawing ED-235-R1)

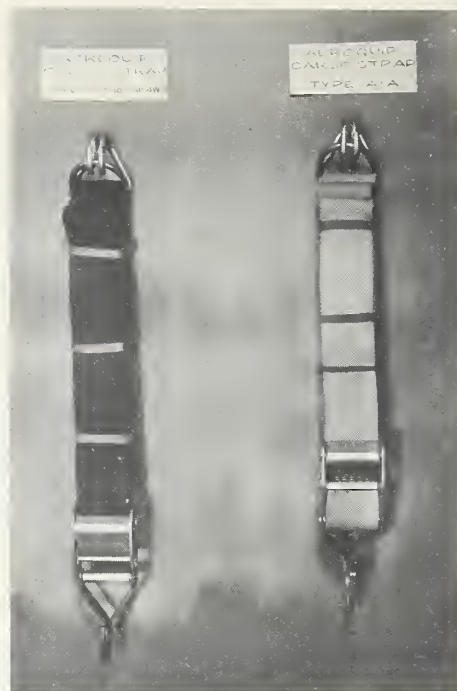


Figure 5



Figure 6

- III. Coding Conveyor Components -- Color coding conveyor components will insure correct mating. If one conveyor is used in both the C-46 and DC-3, two codes can be devised. For instance, one side of the track may be color coded for the C-46, the other side for the DC-3. Code key can be marked on the curved section, since it is used in both aircraft.

AIRCRAFT MODIFICATIONS AND ACCESSORIES

Special modifications and accessories secure the conveyor to the aircraft floor and adjust for floor profiles. The work should be done by an FAA licensed mechanic.

- I. Nut Plates -- Stationary plates which serve as nuts for bolting conveyor to aircraft floor.
- A. Locating Nut Plates -- Nut plate locations are determined by placing conveyor in operating position in aircraft.
1. Place curved section in cargo door so ends do not protude beyond door sill. Position curve center line slightly aft of door center, otherwise tall bundles will strike forward edge of door.
 2. Position curve so straight sections parallel fuselage center line.
 3. Attach straight sections. When conveyor is correctly positioned, mark nut plate locations.
- B. Installing Nut Plates
1. Permanent Nut Plates -- Drill hole through aircraft floor web at nut plate location and rivet a stock aircraft nut plate to the underside of the web (Drawings ED-207-R1* and ED-236-R1). Curved section is secured to permanent nut plates or to holes drilled and tapped in door sill.
 2. Semi-permanent Nut Plates -- Nut plates may be attached to the underside of a false cargo floor of 3/8-inch plywood (Drawing ED-236-R1) which is screwed or bolted to the aircraft floor. Holes must be cut in the false floor to expose aircraft tiedown rings.

*Note: Drawings ED-206-R1 and ED-207-R1 are published in Technical Equipment Report No. 5700-2, April 1961, Accessories for Paracargo and Smokejumper Aircraft, by the Missoula Equipment Development Center.

- II. Overhead Static Line Anchor Cable -- An overhead anchor cable must be used when dropping large bundles or palletized cargo. (Drawing ED-206-R1)
- III. Cargo Tiedown Rings -- Aircraft should be fitted with sufficient FAA approved tiedown rings to secure cargo (Figure 7).

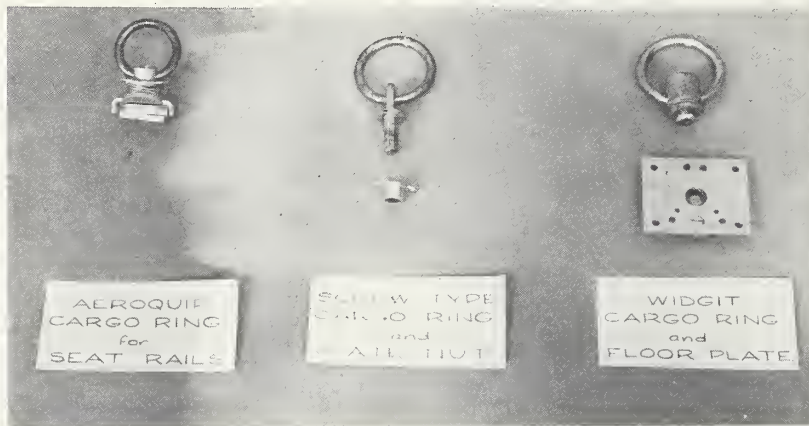


Figure 7

- A. Screw-Type Ring -- Excellent strength (2,500 pounds) and durability (Drawing ED-207-R1).
- B. Widgit Cargo Ring Assemblies -- FAA approved, rated for 1,700 pounds vertical pull. See Technical Equipment Report No. 5700-2 for more detailed information.
- C. Aeroquip Cargo Ring Assemblies -- FAA approved, rating unknown. Fit into passenger seat tracks of many aircraft. Designated P/N E1928 by manufacturer. Like Widgit assembly, is easily damaged, hence our recommendation for screw type.

PROCEDURE

I. Conveyor Installation

- A. Arrange conveyor system as it will be installed in aircraft.
- B. Load forward section first, then work back toward cargo door.

- C. Position curved section in door and bolt into place.
- D. Install straight sections, starting at door and working forward.
- E. Install cargo stop at forward end of conveyor.
- F. Using shims and adjustable legs, adjust conveyor to aircraft floor.
- G. Test door cargo stop and stop release.

II. Loading Sequence and Tiedown Requirements

- A. General -- Payload must not exceed aircraft rating. Maintain proper center of gravity by placing heaviest portion of payload over wing section. See FSH 5715.5 and 5715.22 for detailed loading instructions.
- B. Loading Pallet Units -- Because of their weight, pallets are designed to be moved with a fork lift. However, great care should be exercised not to damage the honeycomb rails. If the rails are appreciably damaged, the pallet may collapse or jam against the rollers, making loading or ejection difficult.

If conveyor space is not sufficient to carry entire payload, place lighter pallets on the floor. Save conveyor space for largest, heaviest bundles. To save time and motion, conveyor loading and floor loading should progress at same rate. Long bundles may be turned crossways on conveyor to conserve conveyor space.

- 1. Load first pallet, push pallet against forward cargo stop, secure with temporary loading stop.
- 2. Push second pallet against first one, remove temporary loading stop and place it to the rear of second pallet.
- 3. Secure second bundle with strap or rope. Tiedown should extend from cargo ring on one side of conveyor to cargo ring on opposite side, crossing upper corner of pallet unit (Figure 8).
- 4. Place cargo strap forward of first pallet to prevent cargo from shifting forward.
- 5. Repeat loading and tying sequence until aircraft is loaded.
- 6. Pallets which have been placed on the floor should be tied down individually.

7. When aircraft is loaded, cargo should be secured with straps forward of every unit and straps or ropes aft of every second or third unit. Two straps should be used to secure the forward end of the load.
 8. Secure the rear of the entire load with two cargo straps, which will prevent a rearward shift on takeoff.
 9. All temporary cargo stops should be removed after the track is loaded.
- C. Loading Individual Packages -- General instructions are covered in FSH 5705.3ld.



Figure 8

1. Load floor to either side of conveyor for 6 or 8 feet, then fill conveyor space.
 2. Repeat this procedure until aircraft is loaded.
 3. Use sufficient tiedown straps to secure the load.
 4. When aircraft is fully loaded, place at least one strap across the front of the entire load and one strap across the rear of the load.
 5. The conveyor should be cleared of all temporary loading stops.
- D. Loading Pallets and Individual Packages Combined -- Pallets are loaded and tied down on the conveyor. Small packages are loaded on the floor and are tied down separately.

III. Cargo Launch Procedure -- Approved cargo dropping rules apply to both pilot and cargo droppers.

A. Pilot.

1. Flying procedures are covered in FSH 5715.32.
2. Aircraft is flown in level to slightly taildown attitude at 90-100 m.p.h.
3. Pallets or packages having more than one parachute must not be dropped below 300 feet.

B. Cargo Droppers.

1. Place doorstop in "UP" position when drop zone is identified.
2. Remove straps or ropes from first pallets to be dropped.
3. Secure remainder of load with cargo stop and cargo strap.
4. Placing a temporary stop behind the units to be dropped will prevent them from rolling away from the door.
5. Hook static lines to parachutes and anchor cable.
6. A man positioned aft of the door trips door stop "DOWN" at pilot's signal and helps guide cargo out the door.
7. Two crew members push and guide load (Figure 9).
8. After cargo is ejected, doorman resets cargo stop and retrieves static lines.



Figure 9

9. Repeat this procedure until aircraft is emptied.
As many as three pallets can be ejected on one pass, depending on size of drop zone, air conditions and size of bundles.

IV. Emergency Cargo Jettison Procedures

A. Preflight Check

1. Check cargo drop and emergency signals with pilot.
2. Each cargo dropper should have a sharp knife readily accessible.
3. Clear conveyor of all obstructions.
4. Enroute to drop zone, door stop should be "DOWN."
5. Do not hook static lines to anchor cable until drop zone is sighted.

B. Jettisoning Cargo in an In-Flight Emergency

1. Cut or release door safety strap.
2. Cut or release tiedowns for first two or three pallets or packages.
3. Move cargo to door and eject it. Do not hook static lines to parachutes unless pilot advises time permits.
4. Continue to eject cargo until plane is empty.

V. Safety Precautions

- A. Always wear a cargo dropper's harness.
- B. Do not step on conveyor rollers.
- C. After freeing units to be dropped on one pass, be sure remaining load is tied down.
- D. Cargo droppers should be sure their harness anchor lines do not become tangled with cargo static lines.

APPENDIX I

Index of Drawings

<u>Page Numbers</u>	<u>Drawing Number</u>	<u>Title</u>
	ED-235-R1	Paracargo Conveyors for DC-3 and C-46 Airplanes
	ED-236-R1	Accessories for Installation of Paracargo Conveyors
	ED-240-R1	Modifications for Paracargo Conveyors

MATERIALS LIST

Drawing No. ED-235-R1

Name	Material	Part No.	Req.	Cutting Size	Color	Size	Specification or Number	Type
Conveyor, Roller	Alum.	1	2			8'0"x24"		
Conveyor, Roller	Alum.	2	1			5'0"x24"	Curve section - 4'6"	
Conveyor, Roller	Alum.	3	1			24"	outside radius	
Conveyor, Roller	Alum.	205	1			8'0"x24"	Shown on Drawing ED-240-R1	
<p>Rollers - 2" diameter, 1/16" wall, die formed round ends, 50-pound capacity.</p> <p>Shafts - No. 17ST4 alum. (through-shaft style).</p> <p>Bearings - hardened steel ball bearings, Type 210.</p> <p>Frame - 8" x 1" x 1/8" channel.</p> <p>Roller Spacing - 3" center to center.</p> <p>Coupling - steel hook and rod type.</p> <p>Style - channel frame rollers above.</p>								
Leg (long), curve	Alum.	4	1					6061-T6
Leg (short), curve	Alum.	5	1					6061-T6
Base plate, stop & release	Alum.	6	1	8" x 30"		5/32"		6061-T6
Spring, release	Spring Steel	7	1	2-1/2"		.032 wire 1/4"		Suspension
Bolts, leg	Steel	8	2			3/8" - 24T	1" long	
Washers, leg bolt	Steel	9	4			3/8"		Flat
Nuts, leg bolt	Steel & Fiber	10	2			3/8"-24T		Fiberlock
Bolts, base plate	Steel	11	6			1/4"-28T	3/4" long	
Stop, cargo	Alum.	12	1	8"x24"		5/32"		6061-T6

MATERIALS LIST

No. ED-235-RI

Name	Material	No.	Part No.	Cutting Size	Color	Size	Specification or Number	Type
Hinge, male	Steel	13	2	3"		1"x1" 16-ga.		Square Tubing
Hinge, female	Steel	14	2	3"		1-1/4"x1-1/4" 16-ga.		Square Tubing
Hinge, Spacer	Steel	15	2	7/8"		1/2", 16-ga.		Round Tubing
Pins, hinge	Steel	16	2			1/4"x1-1/2"		
Key, cotter 16, 26 & 35) (For parts	Steel	17	3			1/16"x1"		
Rivets	Alum.	18	24			3/16"x7/16" Long		
Frame, release	Steel	19	1			.062"		
Holder, bolt	Steel	20	1	3/4"x1 1/4"		1/16"		
Hinge, stop, center	Steel	21	1			.062"		
Link, over center stop lock	Steel	22	1			.062"		
Link, center	Steel	23	1	4"		1"x1" 16-ga.		Square Tubing
Link, end	Steel	24	1	3"		1 1/4"x1 1/4" 16-ga.		Square Tubing
Spring, stop lock	Spring Steel	25	1	2"		1/4" .046	Wire	Suspension
Pin, release, activating	Steel	26	1			1"x1 1/2"	Modified	
(For parts No. 19,								
Bolt 20, 21 & 22)		28	4			1/4"-28T	1/2" long	
Clamp, cable housing	Alum.	29	1					2 parts
Bolts, for part #29	Steel	30	2			3/16"-32T	1 1/4" long	

MATERIALS LIST

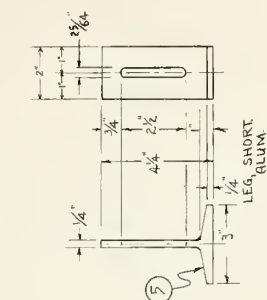
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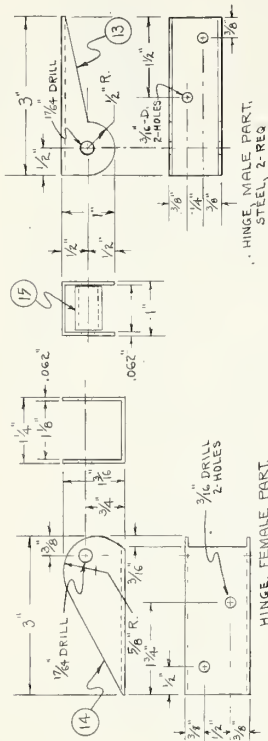
Name	Material	Part No. No.	Reg.	Cutting Size	Color	Size	Specification or Number	Type
Bolt, cable to release arm	Steel	31	1			3/16"-32T	5/8" long	
Bolt, release arm stop	Steel	32	1			3/16"-32T	1" long	
Release, rod, bolt	Steel	33	1			3/16"-32T	4" long	
Nuts	Steel & Fiber	34	6			3/16"-32T		Fiberlock
Bolt, for Parts 23 and 24	Steel	35	1			1/4"-28T	1 1/2" long	5/64" drill
Nut, for Part 35	Steel	36	1			1/4"-28T		Slotted
Stop, release arm	Alum.	37	1	1" x 1/2"		1/4"		
Control arms, lock	Steel	38	1				3 - parts brazed	
Bolt, for Part 38	Steel	39	1			1/4"-28T	1-3/8" long	
Swivel, control arm	Steel	40	1					
Key, cotter (for Part 33)	Steel	41	1			1/32"x1"		
Base, foot release	Alum.	50	1	12"x18"		5/32"		6061-T6
Foot pedal, assembly	Steel	51	1				3 - parts welded	
Frame, pedal	Steel	52	1	3 1/2"x13-1/8"		1/8"		Sheet
Swivel, movable	Steel	53	1					

MATERIALS LIST

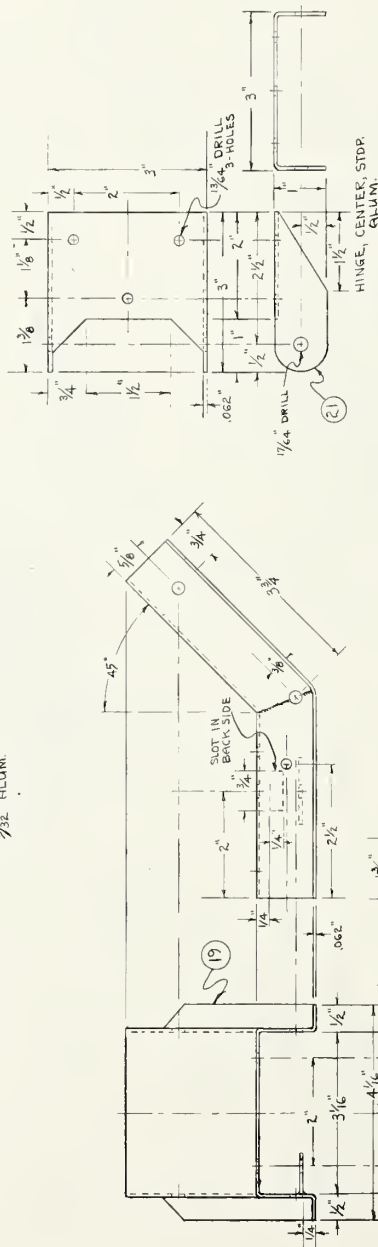
No. ED-235-RL

Name	Material	Part No.	No. Req.	Cutting Size	Color	Size	Specification or Number	Type
Swivel, stationary	Steel	54	1					
Spring, foot release	Spring Steel	55	1	3"		3/8"-0.060	Wire	Suspension
Bolt, foot release	Steel	56	1			5/16"-24T	3-3/4" long	
Nut (for Parts 54 and 56)	Steel & Fiber	57	2			5/16"-24T		Fiberlock
	Steel & Fiber	58	12			1"-28T		Fiberlock
Control Assembly		59	1	- unit			Weatherhead #8354	Push-pull
Stop, forward shift	Alum.	70	1	14"x26"		1/8"		6061-T6
Facing, plywood	Alum.	71	2	3"x23-15/16"		1/8"		6061-T6
Spacer	Ply- wood	72	1	3"x23-15/16"		3/4"	BB	Fir
Rivets	Alum.	73	9			1"x1 1/4"	Long	Countersunk head
Rivets	Alum.	74	12			3/16"x7/16"	Long	
Clamp	Alum.	75	2					6061-T6
Bolts, clamp	Steel	76	2			3/8"-24T	3/4" long	Wing screw
Ends, triangular	Alum.	77	2			1/8"		6061-T6
Stops, loading	Plywood	78	4	10"x20"		3/4"	BB	Fir

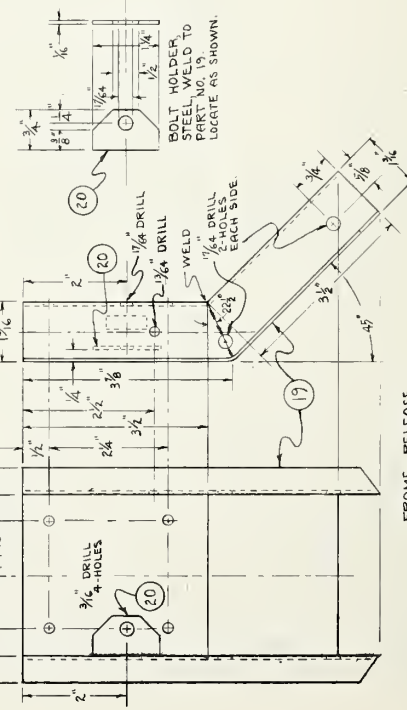




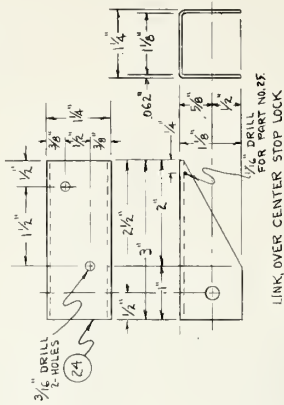
STOP, " CARGO,
5/32 ALUM.



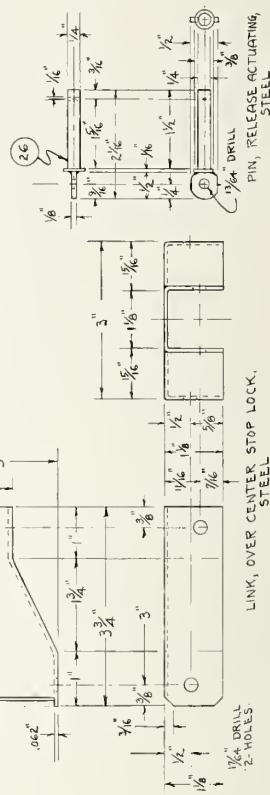
HINGE, CENTER, STDP.
ALUM.



FRAME, RELEASE
STEEL
WELDED CONSTRUCTION.

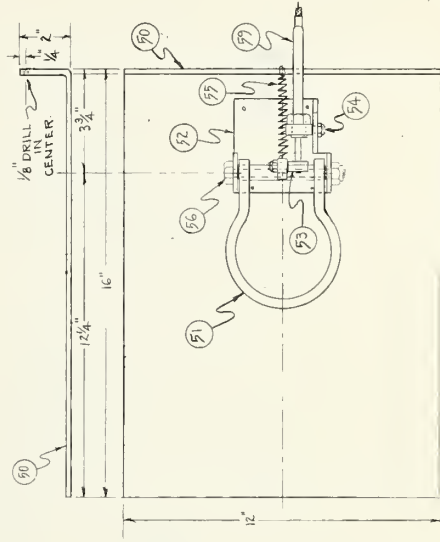
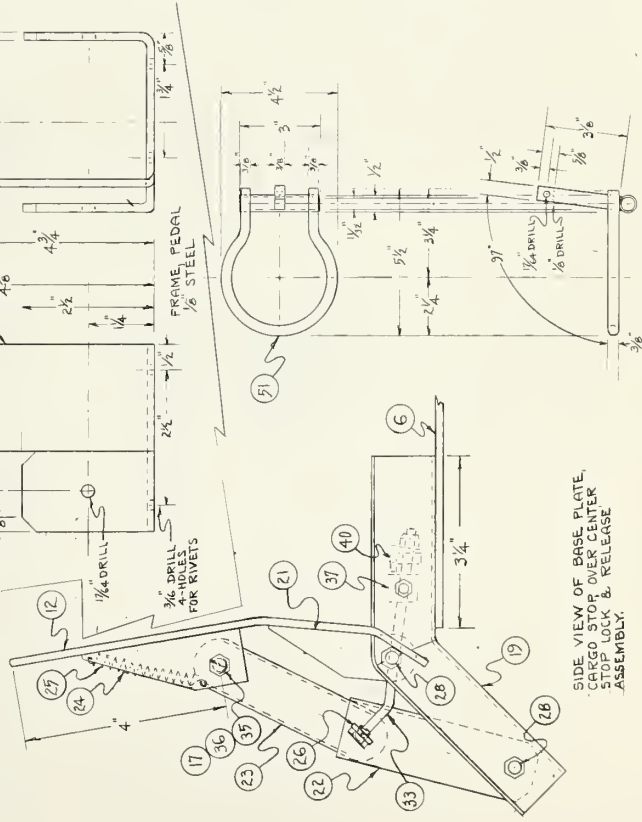
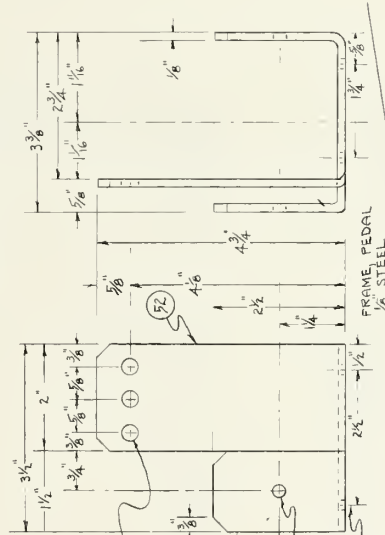
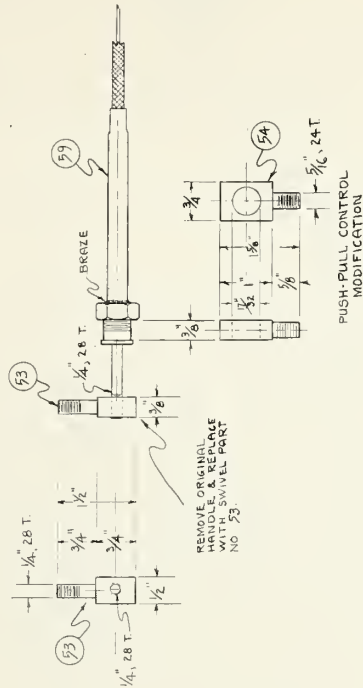
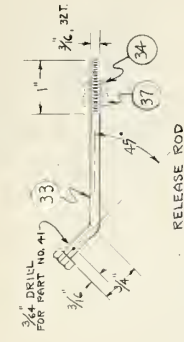
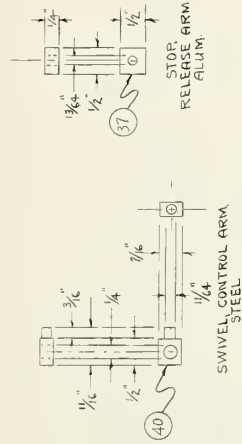
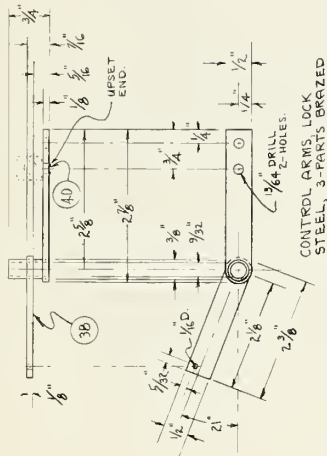
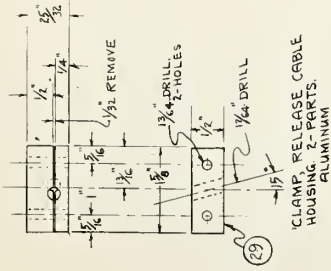


LINK, OVER CENTER STOP LOCK



LINK, OVER CENTER STOP LOCK,
STEEL

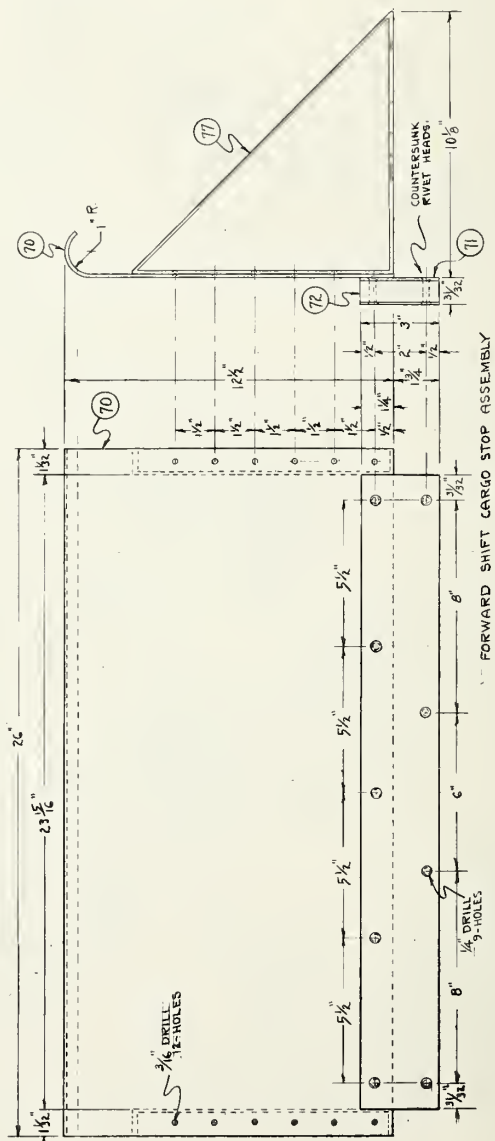
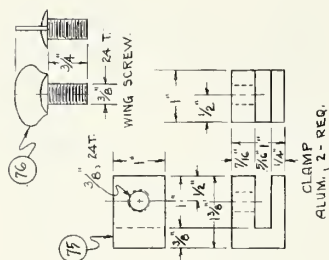
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PEDAL, FOOT STEEL 3-PARTS WELDED

SIDE VIEW OF BASE PLATE, 3-PARTS WELDED

U.S. DEPARTMENT OF AGRICULTURE	FOREST SERVICE	INNOVATION DIVISION	RESEARCH CENTER
PARACARGO CONVEYOR	FOR DC-3C AND C-4C AIRPLANES	ED-239-RJ	3-71
DATE	AS SPEC	DATE	MAY 67



604	STATE	LOADING	4-12
U. S. DEPARTMENT OF AGRICULTURE FOODST SERVICE			
MISSOURIA RESEARCH DEVELOPMENT CENTER			
PARACATCH CONVEYOR FOR DC-3C AND C-46 AIRPLANES			
MAILED BY: ABE		121-70700 100000	
DATE: MAY 1964		ED-235-RL	
NAME: AS 5062			
DATE: MAY 1964			

MATERIALS LIST

Drawing No. ED-236-R1

Name	Material	Part No. No. Req.	Cutting Size	Color	Size	Specification or Number	Type
Clamp, conveyor	Alum.	101	7			5 - parts riveted	6061-T6
Rivets	Alum.	102	56		3/16"x3/4"		Countersunk head
Bolts	Steel	103	14		3/8"-24T	1-3/4" long	
Washers	Steel	104	14		3/8"		Flat
Plate nuts	Steel & Elastic	105	14		3/8"-24T		Elastic lock
Rivets, for plate nuts	Alum.	109	28		1/8"x3/4"		Countersunk head
Nut plate	Steel	110	14		3"x4"x1/8"	Rivet to Part III	
Nut plate	Steel	111	14		1"x2"x1/4"		
Rivets	Steel	112	28		1/4"x1/2"		Countersunk head
Bolts	Steel	113	14		3/8"-24T	1" long	

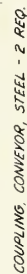
Drawing No. ED-240-R1

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MATERIALS LIST

No. FD-240-R1

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NOTE: THIS DRAWING MUST BE
USED IN CONJUNCTION
WITH DRAWING
NO. ED-235-R1.

DATE	OFFICIAL	87
U. S. DEPARTMENT OF AGRICULTURE FOREST SERVICE MASSOULA EQUIPMENT DEVELOPMENT CENTER		
MODIFICATIONS FOR PARACARGO CONVEYORS		
DRAWN BY <i>A.H.J.</i> CHECKED <i>E.M.</i> DESIGNED <i>A.H.J.</i> MADE AS SPEC.	RELEASE NUMBER ED-240-R1 WEIGHT 100	



